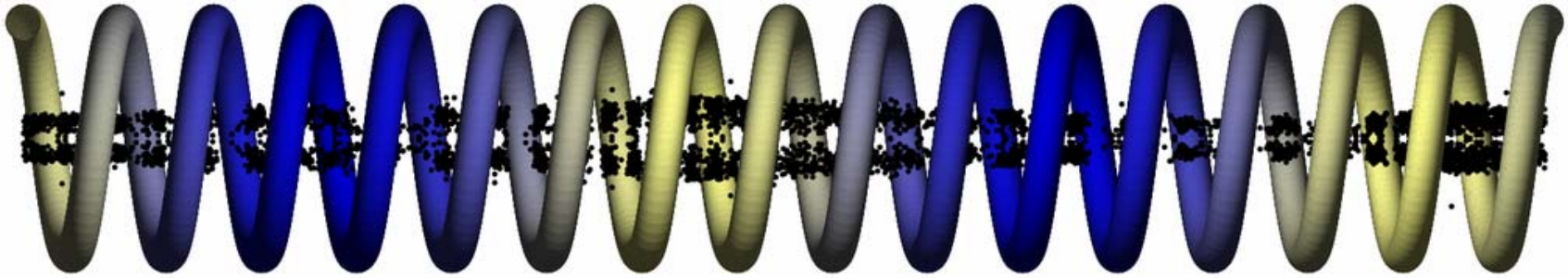
communications

Electron Technologies, Inc.



NRL Code Overview/Status

Will Menninger, Xiaoling Zhai, Bill McGeary

Space TWT/LTWTA

Sept 15, 2005

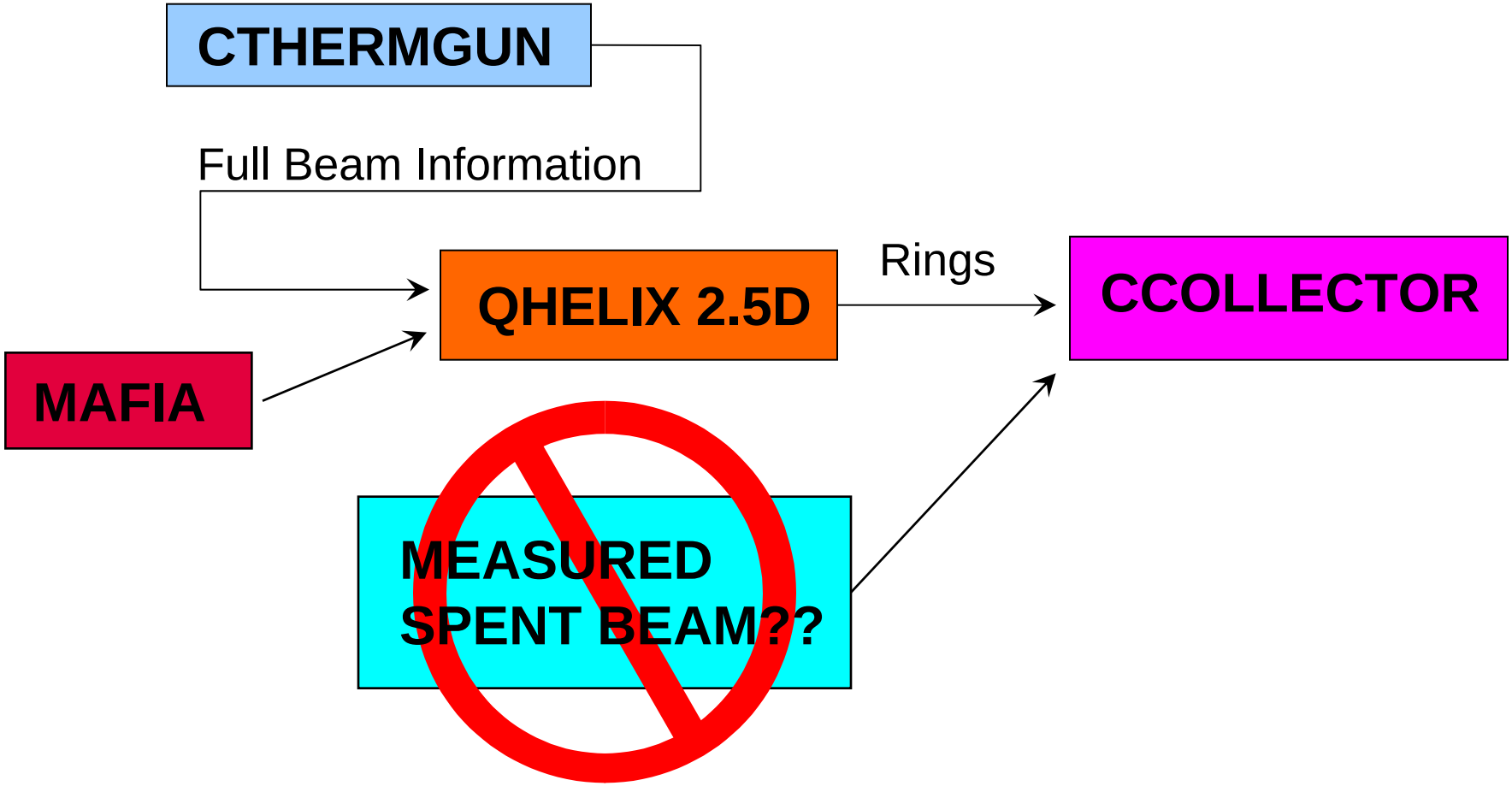
Outline

- **Introduction**
- **How we use NRL codes**
  - ***Michelle 3D***
  - ***Christine 3D***
- **Recent advances**
  - ***Ku-band and C-band Efficiency***
  - ***Ka-band Power Handling***
- **Example Problem**
  - ***TWTA turn-on***
- **Summary/Wish List**

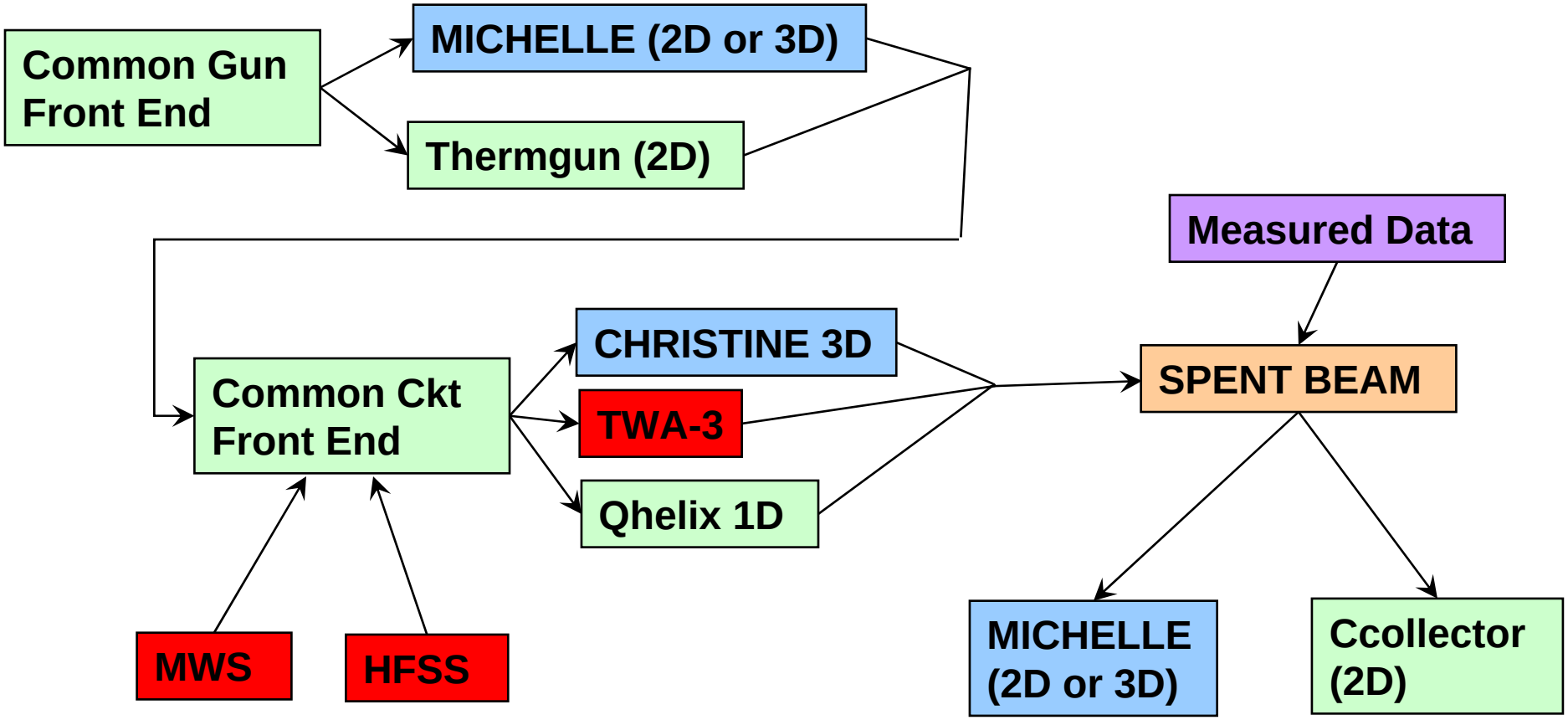
Introduction

- **Space TWT customers want "everything."**
  - ***Efficiency, High power, Reliability, Flexibility, Schedule***
- **There is rarely time to iterate a design or build prototypes.**
- **Modern design codes which can handle large, 3D TWT problems are critical.**
- **Commercial TWT codes are not readily available and/or are expensive.**
- **Paying specialists to write proprietary modeling codes is expensive and problematic.**
  - ***Many scientists are not especially skilled programmers.***
  - ***What if employee leaves?***
- **MICHELLE 3D and CHRISTINE 3D provide an excellent solution.**

Design Flowchart from IVEC 2000

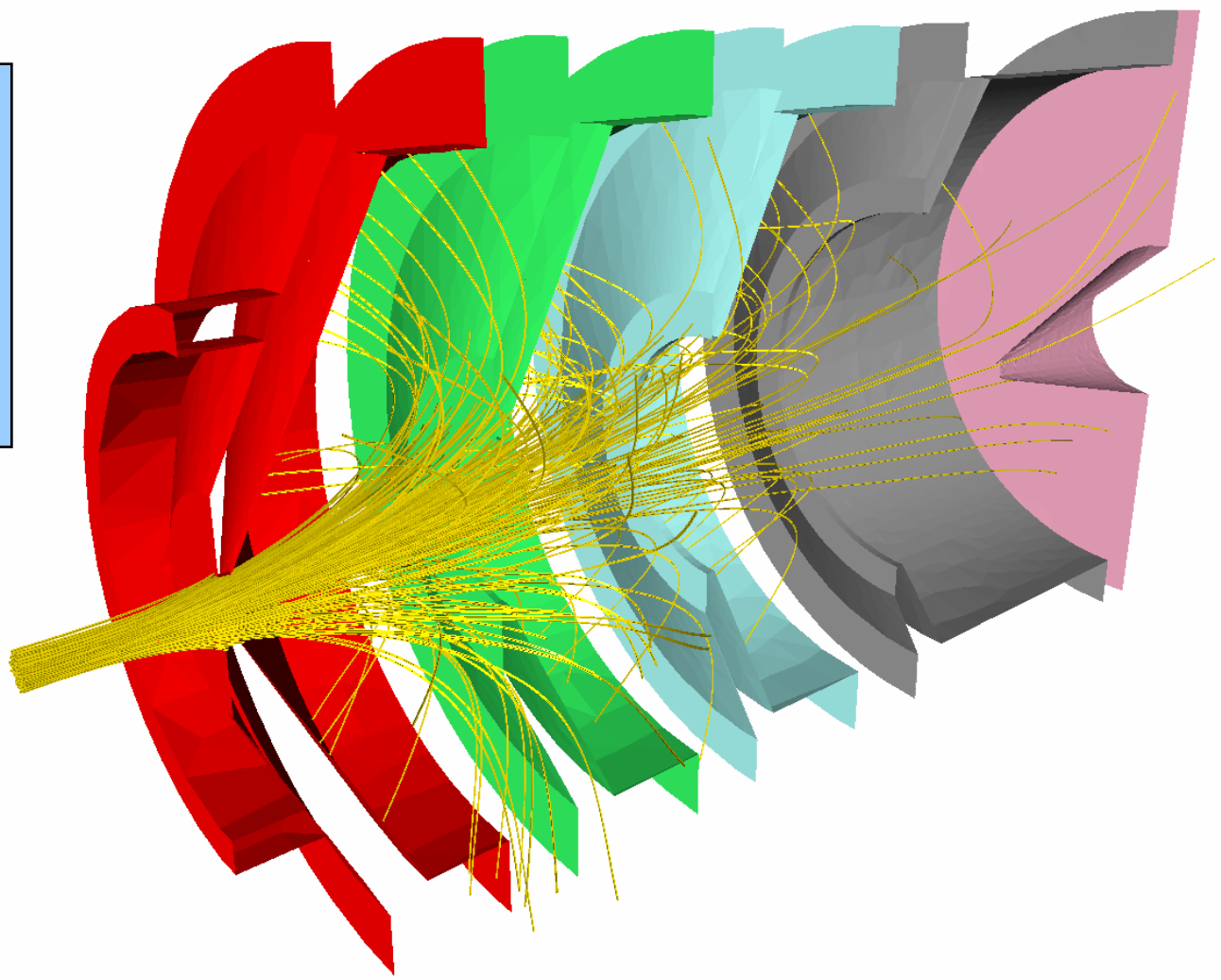


Updated Design Flowchart (2005)



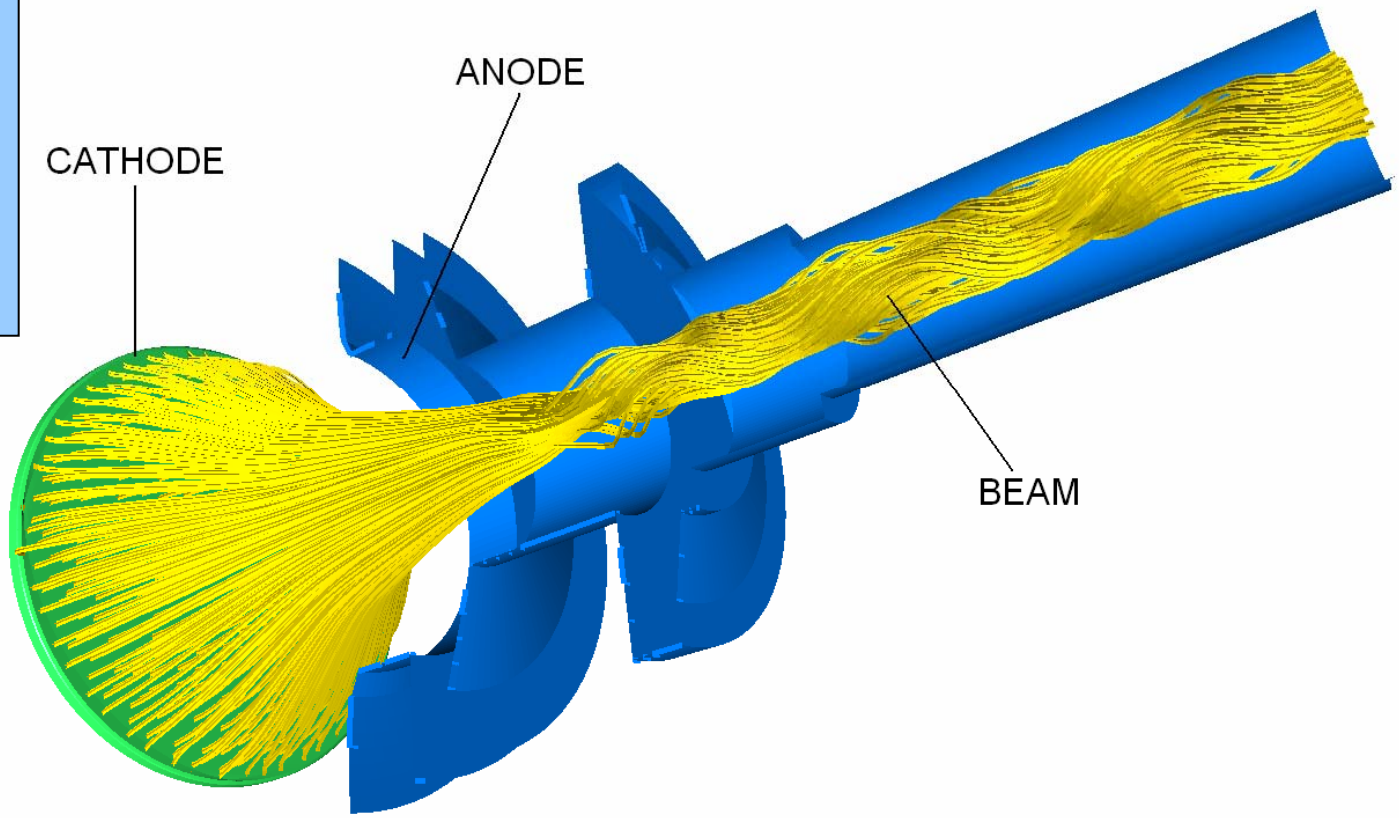
MICHELLE 2D/3D: Collector Design

Critical for optimizing efficiency and minimizing backstreaming.



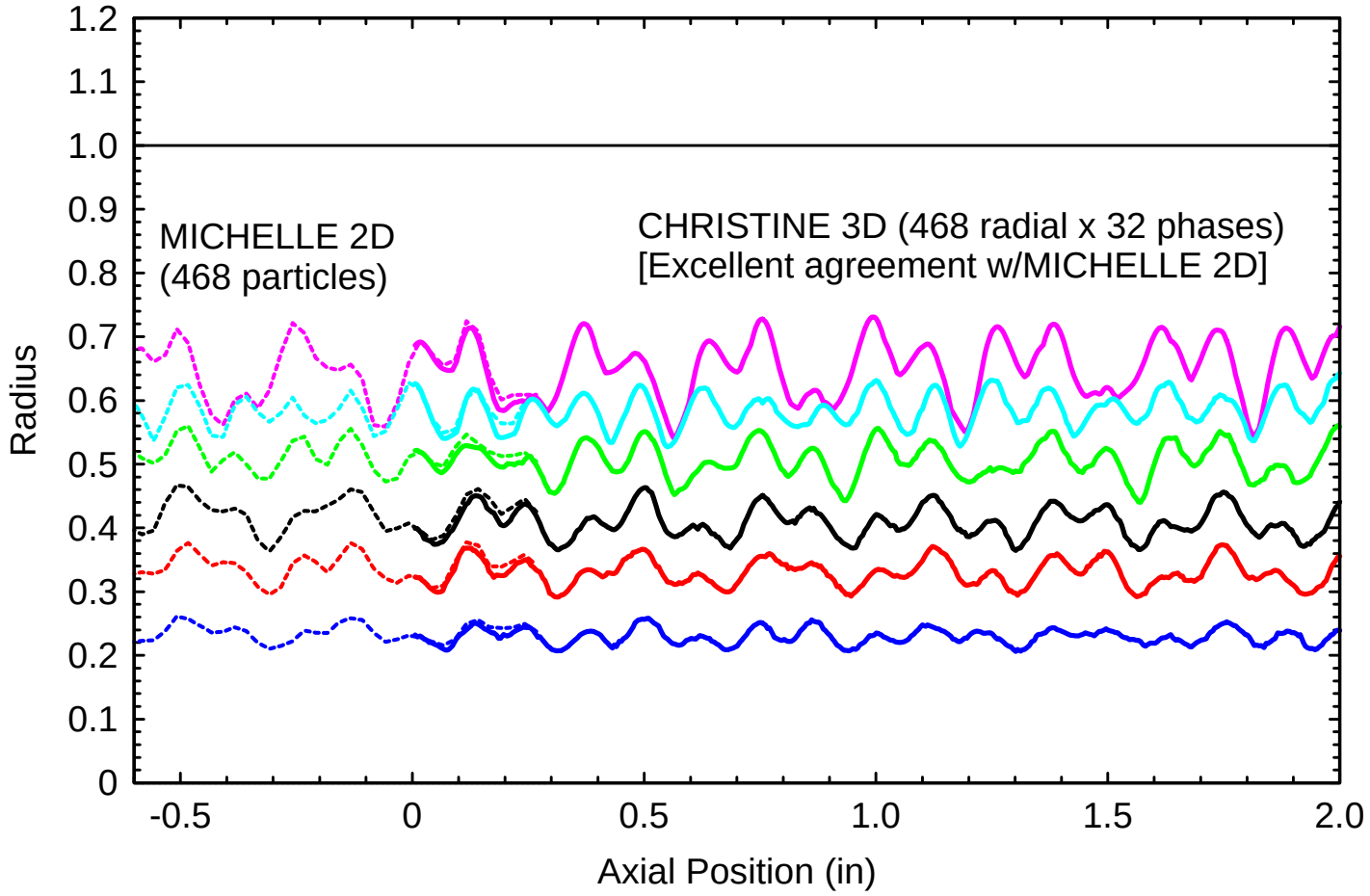
MICHELLE 2D/3D: Gun Optics

- **2D: workhorse gun design code.**
- **3D: study misalignment problems and tolerancing.**

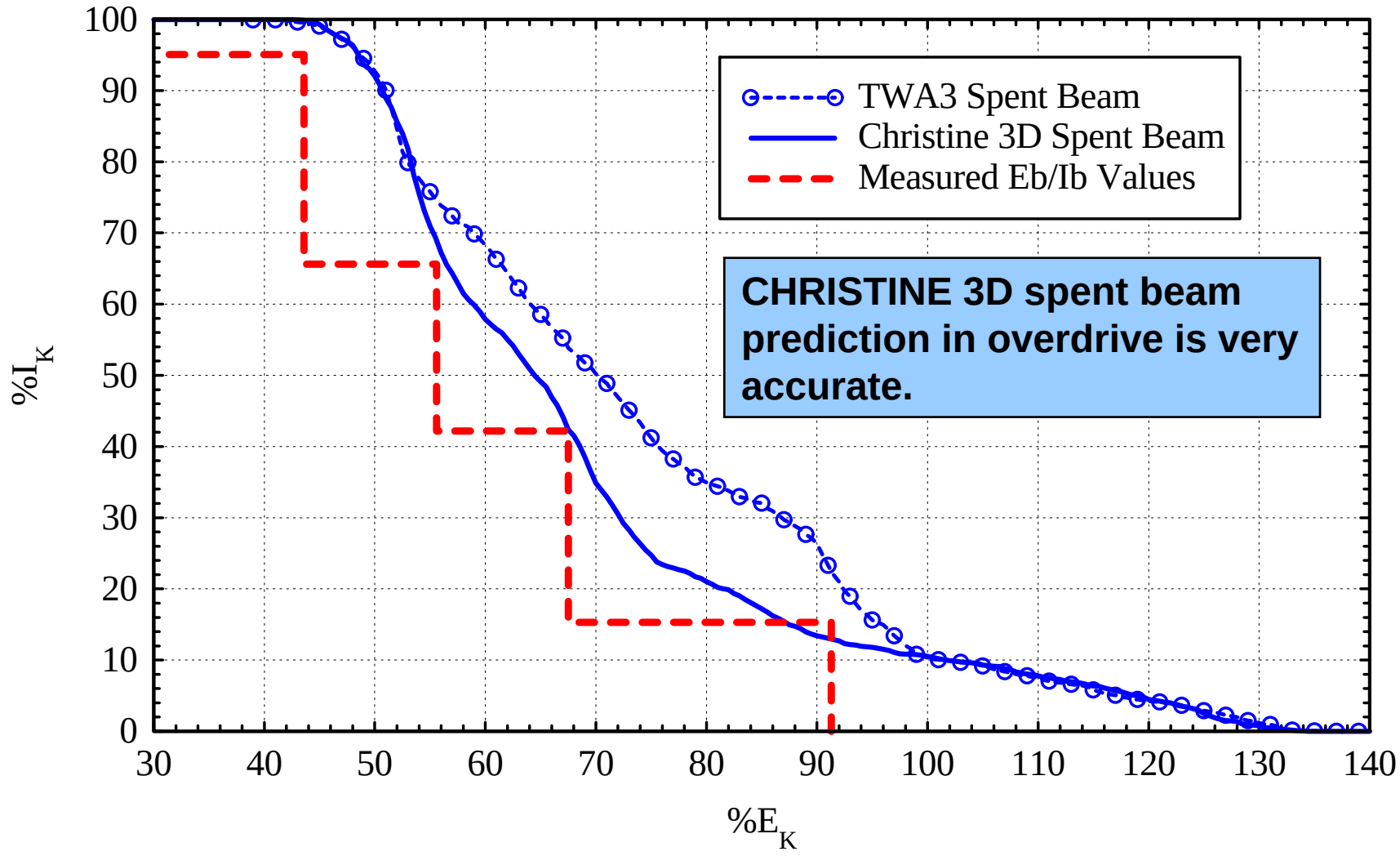


CHRISTINE 3D

Good hand-off between MICHELLE 2D and CHRISTINE 3D



Christine 3D Accurate Modeling



CHRISTINE 3D Speed

One pass, Ku-band, ~2000 particles, 3 frequencies

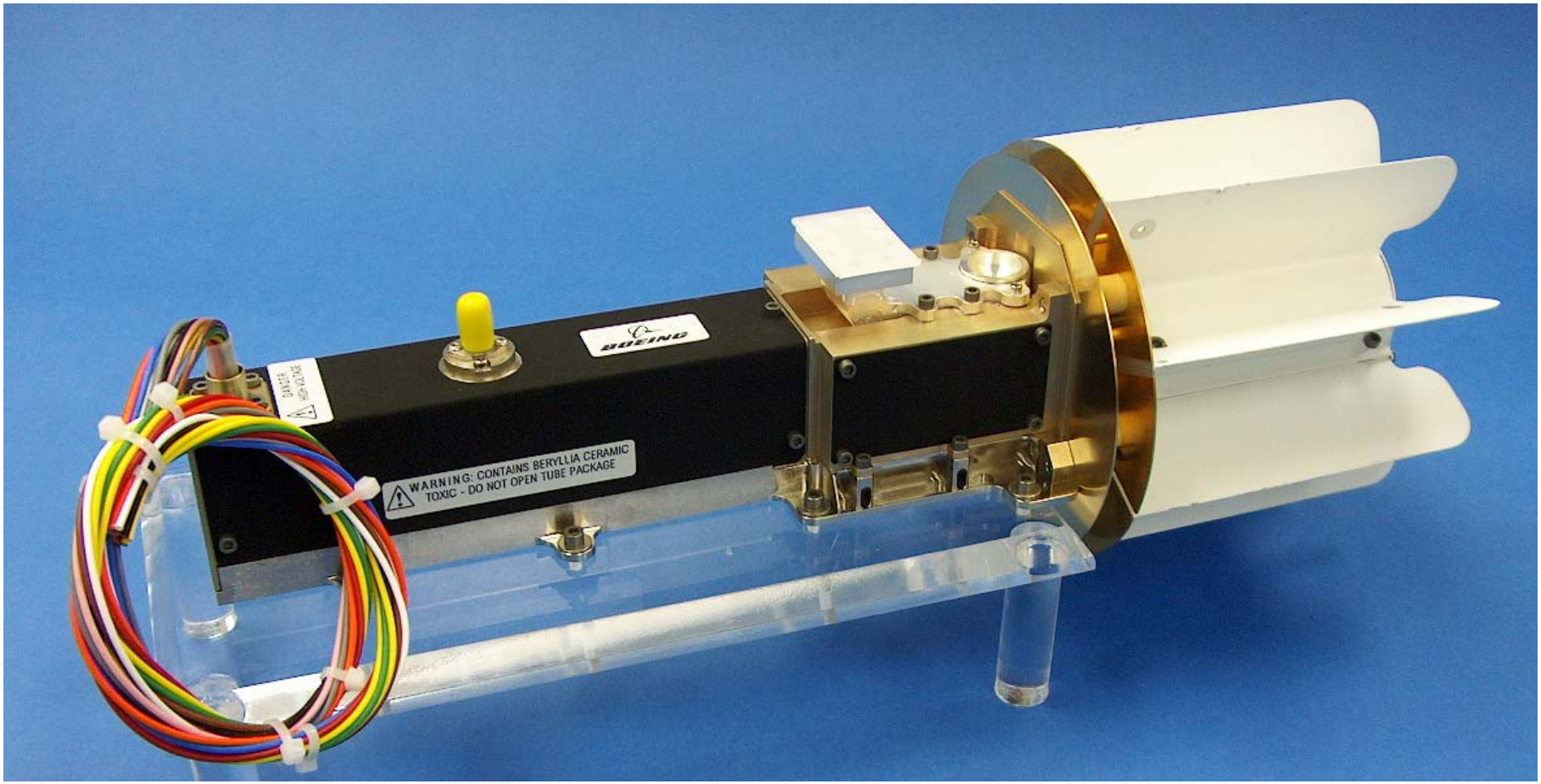
Code	Processor	Compile Line	Run Time
CHRISTINE 3D	2.2 GHz Opteron	g77 v3.3 –m64 –O3 –ffast-math	**130 s**
TWA3	2.2 GHz Opteron	ifc v7.1 –O3 –xW –Ob2 –tpp7 –ip –ipo –ipo_obj	**115 s**

Code	Processor	Compile Line	Run Time
CHRISTINE 3D	3 GHz P4	g77 v3.2.3 –O3 –ffast-math –fomit-frame-pointer	**158 s**
TWA3	3 GHz P4	ifl v2.4 /G6 /Ox	**148 s**

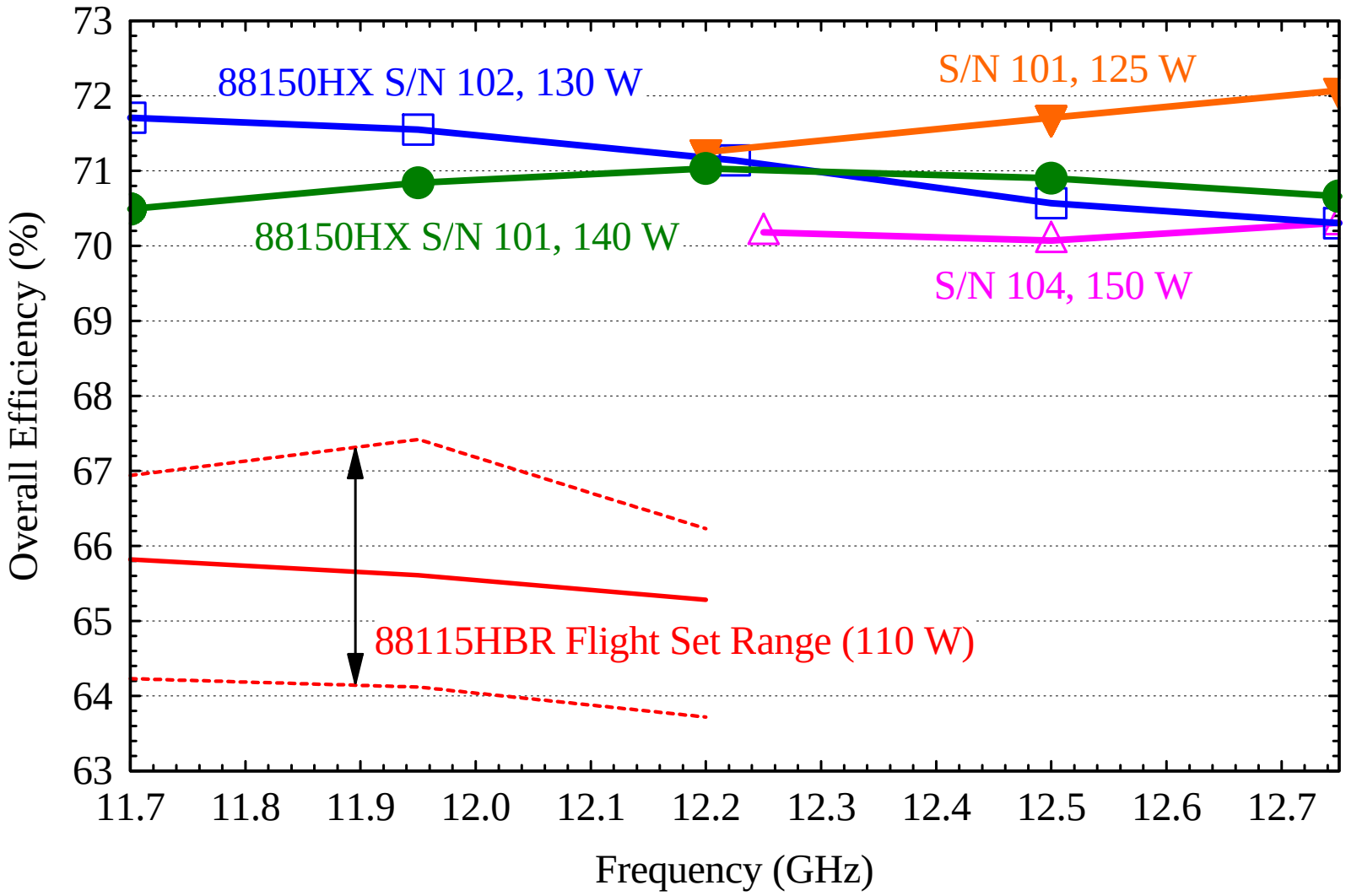
TWT Improvements at ETI

- **Ku-band and C-band Efficiency**
  - ***Efficiency requires all areas of TWT to be accurately modeled and tuned: Gun, Circuit, Window, Collector***
  - ***Accurate 3D codes such as CHRISTINE 3D and MICHELLE 3D are critical.***
- **Ka-band Power Handling**
  - ***Power handing requires precision gun modeling, low body current, and well-designed collector optics which avoid backstreaming.***
  - ***Again, CHRISTINE 3D and MICHELLE 3D are must-have design tools for this process***

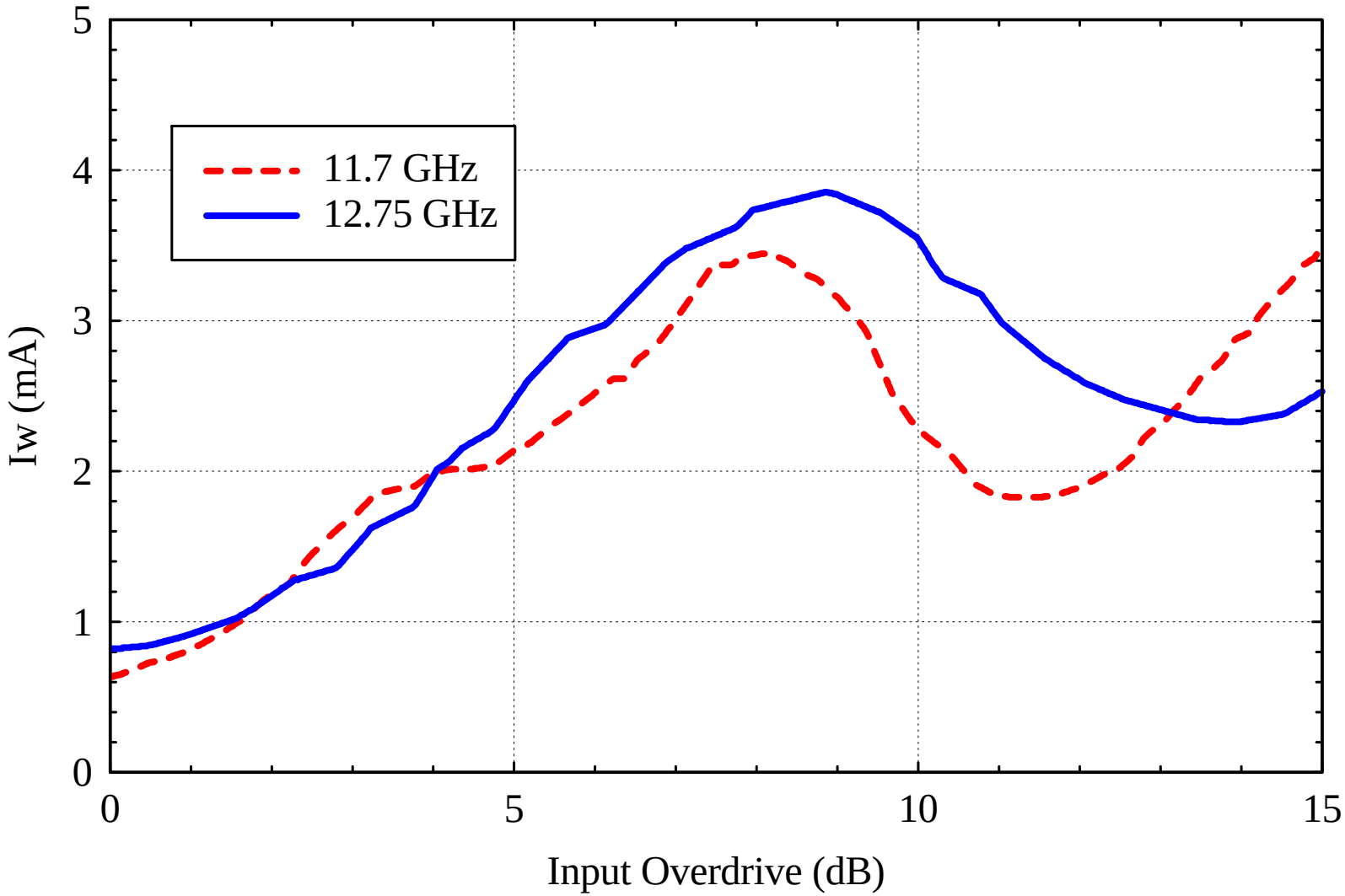
88150HX Ku-band TWT (30 – 150 W)



88150HX Efficiency

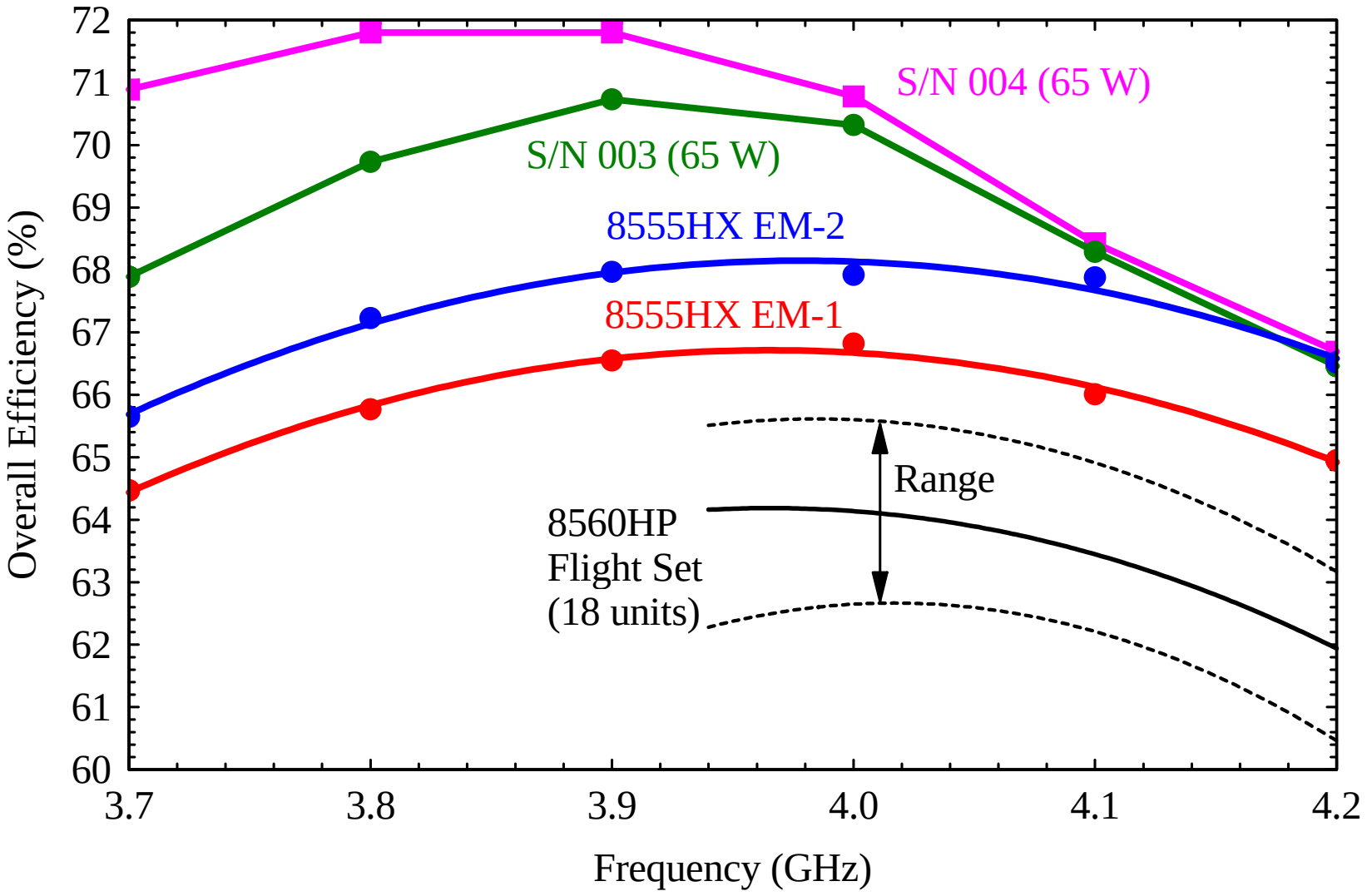


88150HX Overdrive Body Current



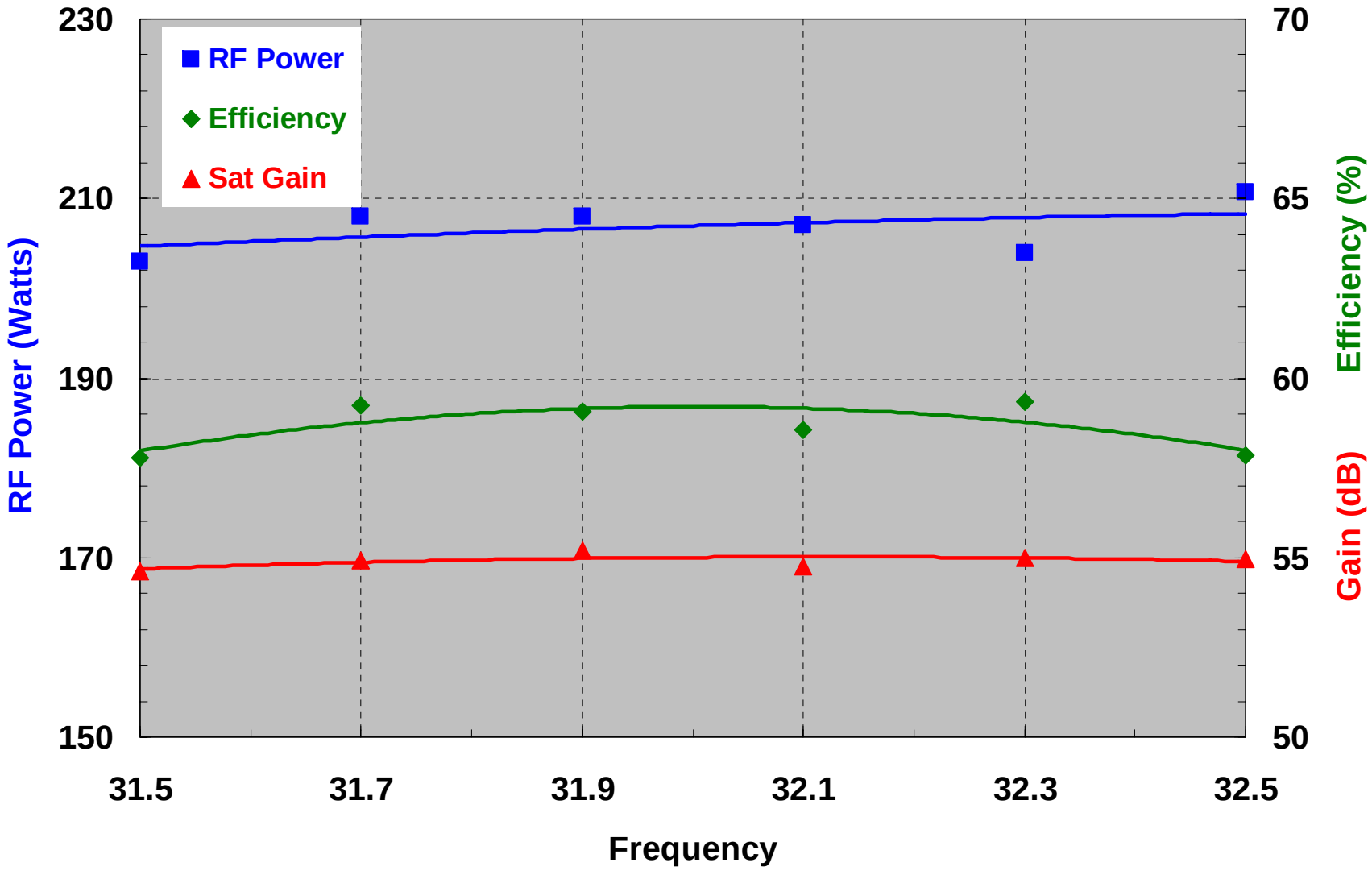
8555HX C-band TWT (30 – 100 W)

8555HX Efficiency

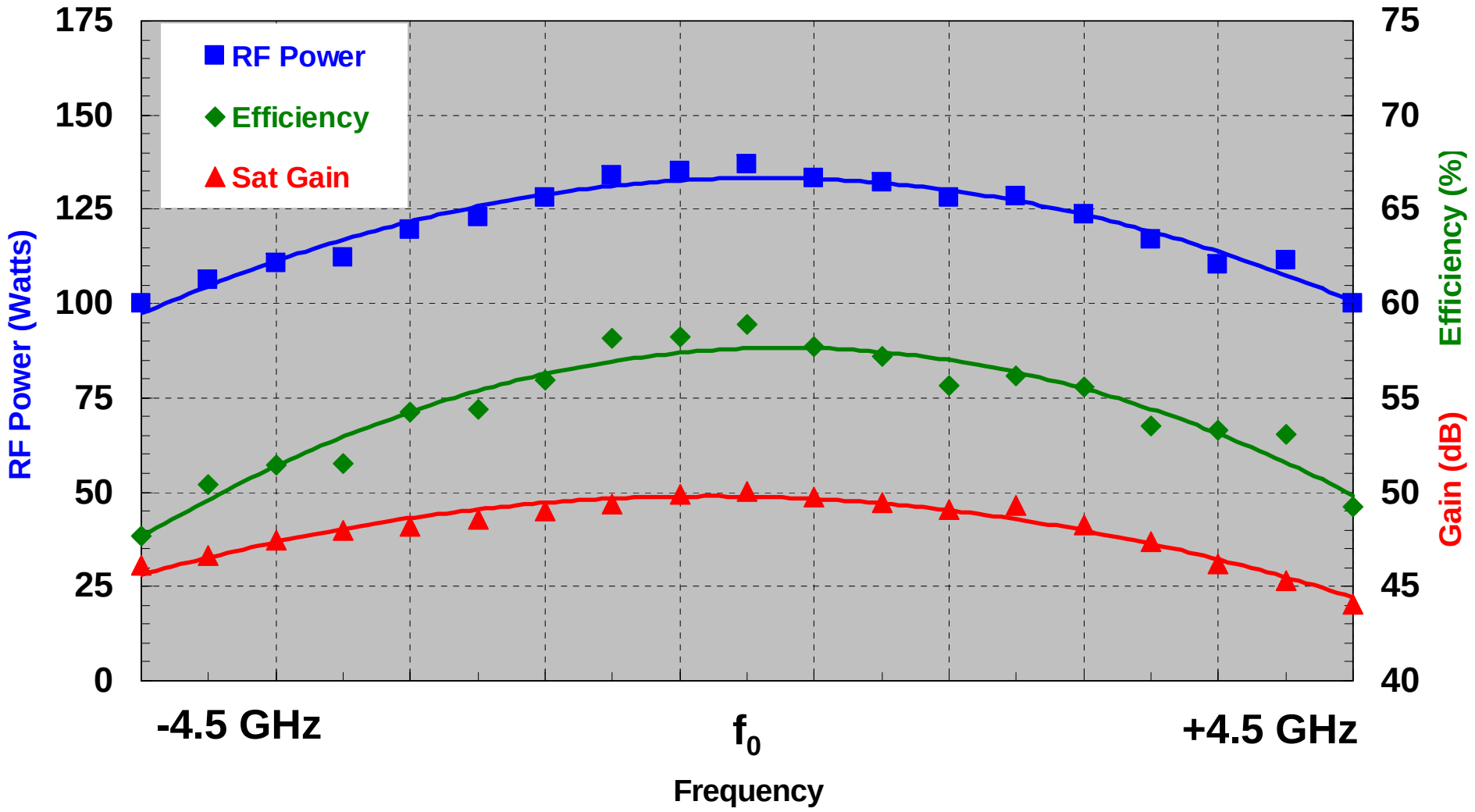


999HA Ka-band TWT* (100 – 250 W)

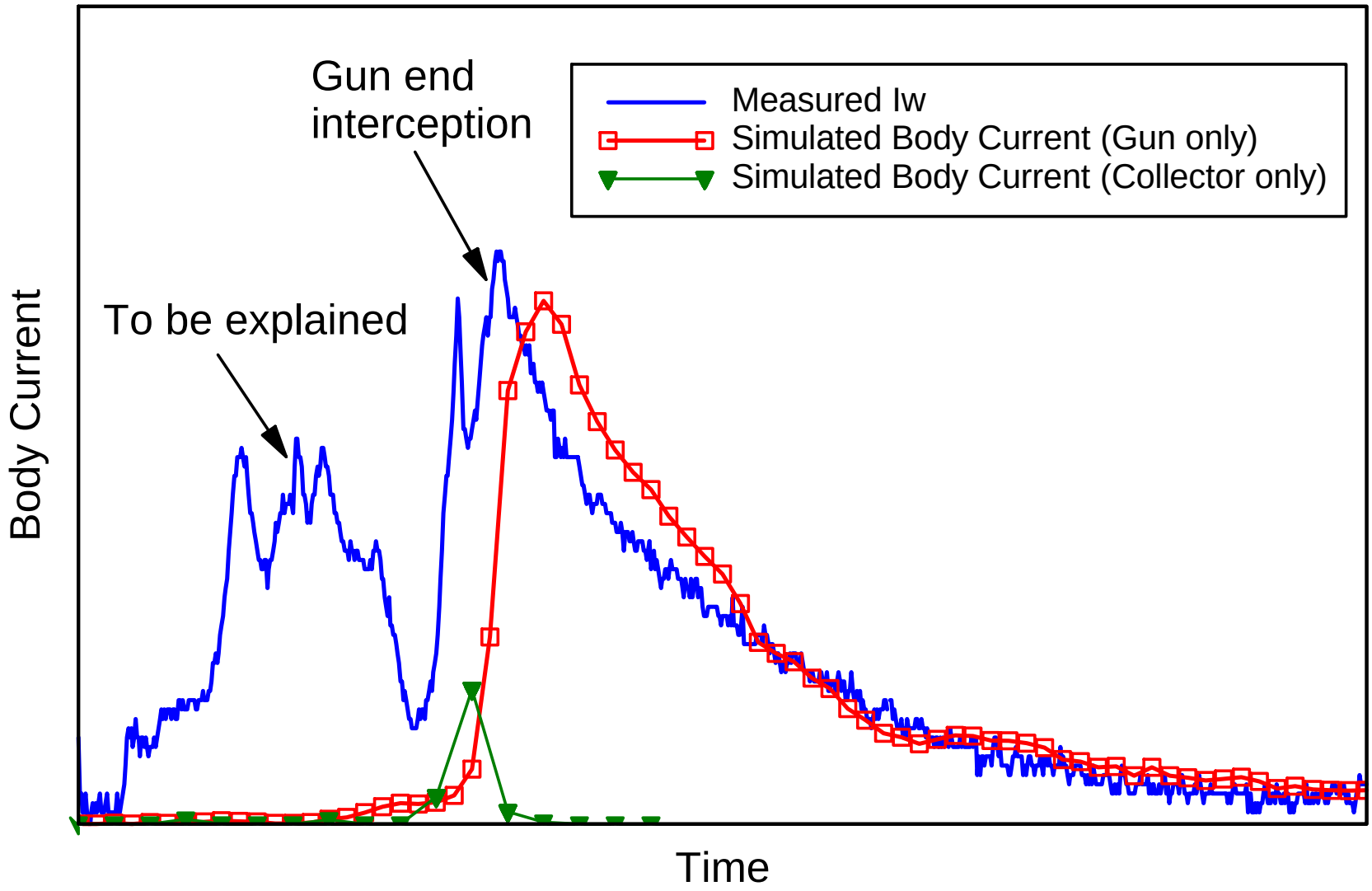
999HA High Power Performance



999HA Wideband Performance (9 GHz)



Example Problem: TWTA Turn-on



Summary

- **Today's market demands high-performance, high-reliability, high-power TWT's, and this requires accurate modeling.**
- **NRL CHRISTINE 3D and MICHELLE 2D/3D codes are an integral part of L-3 ETI success.**
  - ***MICHELLE 3D, in particular, is the only solution for 3D gun and collector design at L-3 ETI.***
  - ***CHRISTINE 3D has proven to be the most accurate TWT circuit code in use today.***
- **All TWT designs in both space and ground groups are designed with NRL codes.**

Wish List

- **MICHELLE Optimization**
  - ***Electrode shapes***
  - ***Electrode voltages***
- **x86-64 Linux version of MICHELLE**
- **CC-TWT fast, accurate modeling solution**